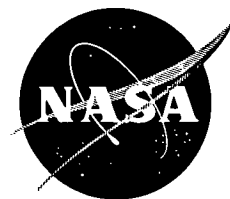
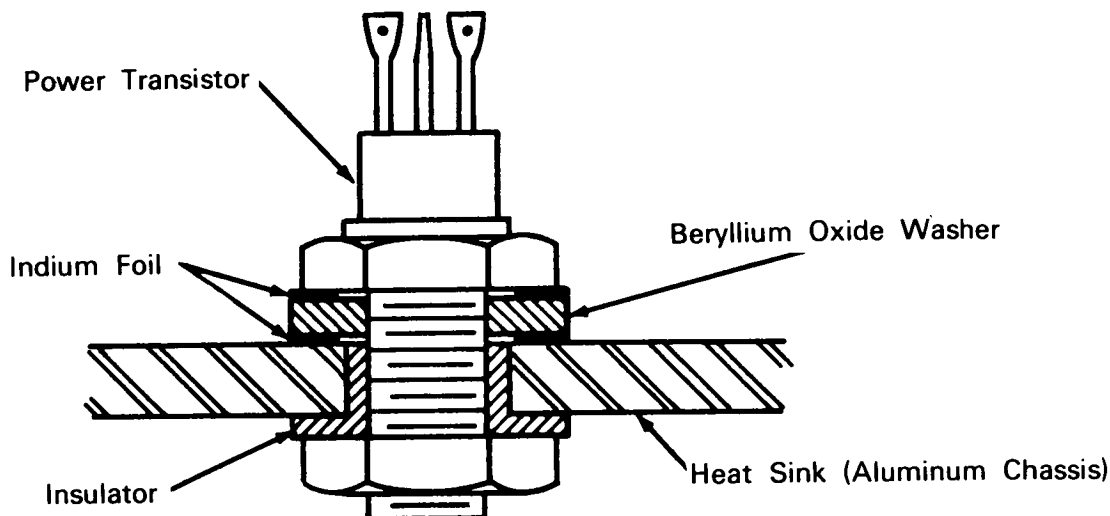


NASA TECH BRIEF



This NASA Tech Brief is issued by the Technology Utilization Division to acquaint industry with the technical content of an innovation derived from the NASA space program.

Indium Foil with Beryllia Washer Improves Transistor Heat Dissipation



The problem: The cooling of power transistors in a vacuum environment, where the only available modes of heat transfer are conduction to a heat sink and radiation from the heat sink to ambient space. The resistance to the flow of heat from the case of the transistor to the heat sink (such as an aluminum chassis) on which the transistor is mounted should be as low as possible. It is often necessary, however, that the transistor be electrically insulated from the heat sink. Commercially available washers made of beryllia (beryllium oxide) combine good thermal conductivity with high electrical resistivity and therefore have come into use as spacers in the mounting of transistors on heat sinks. However, because of the essentially granular nature of beryllia, the contact thermal resistance at the interfaces on both sides of the beryllia washer can seriously reduce the effectiveness of the washer in vacuum. Although the contact resistance can be

decreased by increasing the torque applied to the transistor mounting nuts, the resulting high compression may crack the beryllia washer.

The solution: Insertion of indium foil at the interface between the beryllia washer and the heat sink and between the beryllia washer and the base of the transistor case. The use of indium foil as an interface material reduces the thermal resistance of the beryllia washer to almost 1/8 of its value without the interface material. The effect of the soft foil is to fill the void between the surfaces with heat-conducting material.

Although the effect of surface compression is critical when the beryllia washers are used alone, it is not of too much importance when the indium foil is used. Sufficient torque may be applied to the mounting nuts without danger of cracking the beryllia washers.

(continued overleaf)

Notes:

1. The use of indium foil is especially valuable in vacuum, where heat dissipation can be achieved only by conduction and radiation. It is of less importance in environments where natural or forced convection is possible.
2. Although washers of other soft metals, such as lead or zinc, can be effective, the sublimation rate of these metals, which is higher than that of indium, precludes their use in vacuum. Even at a temperature of 400°C, the rate of sublimation

of indium in high vacuum is only 10^{-5} centimeter per year.

3. Detailed information on the use of the indium as interface material is given in NASA TN D-1753, *Power Transistor Cooling in a Space Environment*, by James E. A. John and J. J. Hilliard, Goddard Space Flight Center, July 1963.

Patent status: NASA encourages commercial use of this innovation. No patent action is contemplated.

Source: Goddard Space Flight Center (GSFC-42)